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Waste Disposal from Livestock Markets

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PREFACE

This publication provides livestock market owners and operators general guidelines and possible options for handling wastes. It also contains some unpublished research results related to cleaning livestock holding pens and alleyways.

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24510 Waste Disposal from Livestock Markets

Herman F. Mayes and Verle W. Fischer¹

A large portion of livestock raised in the United States moves through public livestock markets. These markets include terminal or auction markets, country buying stations, and country dealers.

Many state laws and regulations that apply to feedlots also apply to livestock markets. For example, The Minnesota Pollution Control Agency defines a feedlot as "the confined feeding, breeding, raising, or holding of livestock in enclosures specifically designed as confinement area in which animal manure may accumulate (1)." They include livestock markets in this definition. Some states specifically exclude livestock auction markets from their regulations. Other states are more specific—they include livestock markets in their list of animal confinement facilities that come under their regulations.

Wastes from livestock markets are different

from wastes from feedlots. Animals confined in a feedlot are generally one species, while livestock markets may contain several species. Wastes from a livestock market also are different because they can be diluted with water from cleaning the market facilities.

Disposing of wastes from these market facilities is not a new problem. In large cities the location of terminal markets has increased the constraints on waste disposal. Before current regulations for governing waste disposal were established, a few markets tried to dehydrate wastes from cattle and sheep pens. Problems involved in operating these dehydrating plants included high initial cost, mechanical difficulties, high energy requirements, unpleasant odors, and severe corrosion of dryer parts. These problems caused the livestock markets to abandon the dehydrated manure market. Another problem the livestock markets had was the runoff of rainfall on open pens.

SOURCE OF WASTES

Livestock Species

All species of livestock are handled by public livestock markets. However, specific markets in specific locations may handle only one or two species. An example of this would be a country buying station for hogs. Each of these species produces different amounts and types of wastes. The daily production rate of manure for each livestock species is given in table 1 (2).

The amount of manure produced by livestock while in a public market will vary from the values given in table 1 because of handling, transporting, and change in feed environment. The amount of change in daily manure production because of these factors is not known.

Another factor to consider is the time livestock stay in the market facility. An estimate of the total weight of each species for each hour of the day can be used in determining daily occupancy. This weight estimate should be calculated for several days so the number of head and total weight of each species handled can be calculated on a daily basis. As an example, a typical occupancy time might total 57 percent for a market-selling, butcher-weight hog.

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TABLE 1.—*Manure production and characteristics per 454kg (1000 lb) live weight¹*

Item	Units	Dairy		Beef		Swine		Sheep	Horse
		Cow	Heifer	Yearling 182-318 kg (400-700 lb)	Feeder 318 kg (700 lb)	Feeder	Breeder		
Raw waste (RW)	kg/day	37.2	38.6	40.8	27.2	29.5	22.7	18.1	20.4
	lb/day	82.0	85.0	90.0	60.0	65.0	50.0	40.0	45.0
Feces/urine ratio		2.2	1.2	1.8	2.4	1.2		1.0	4.0
Density	kg/m ³	1,005.0	1,005.0	1,010.0	1,010.0	1,010.0	1,010.0		
	lb/cu ft	62.7	62.7	63.0	63.0	63.0	63.0		
Total solids (TS)	kg/day	4.7	4.2	5.2	3.1	2.7	1.9	4.5	4.3
	lb/day	10.4	9.2	11.5	6.9	6.0	4.3	10.0	9.4
	percent RW	12.7	10.8	12.8	11.6	9.2	8.6	25.0	20.5
Volatile solids	kg/day	3.8			2.7	2.2	1.4	3.8	3.4
	lb/day	8.6			5.9	4.8	3.2	8.5	7.5
	percent TS	82.5			85.0	80.0	75.0	85.0	80.0
BOD ₅ ²	percent TS	16.5			23.0	33.0	30.0	9.0	
COD ³	percent TS	88.1			95.0	95.0	90.0	118.0	
TKN ⁴	percent TS	3.9	3.4	3.5	4.9	7.5		4.5	2.9
P ⁵	percent TS	0.7	3.9		1.6	2.5		0.66	0.49
K ⁶	percent TS	2.6			3.6	4.9		3.2	1.8

Source: 1978 Agricultural Engineers Yearbook, American Society of Agricultural Engineers, p. 465.

¹ Numerical values for kg/day/1,000 kg live weight are the same as those for lb/day/1,000 lb live weight.

² 5-day biochemical oxygen demand.

³ Chemical oxygen demand.

⁴ Total Kjeldahl nitrogen.

⁵ Phosphorus.

⁶ Potassium.

Water Troughs

Another large source of waste water from livestock markets is water troughs. Some terminal market commission firms allow the water troughs to overflow continuously. This overflow water may come in contact with bedding and manure before it is discharged to a treatment facility or may cause a pollution problem if discharged to a stream. As pollution regulations have become more stringent, the cost of treating this waste water has increased.

Several market firms have installed automatic waterers to reduce or control water use; however, freezing may be a problem if electricity or propane heat is not available.

One solution includes a closed loop system from a control tank that prevents freezing. A pump similar to that in a home hot water heating system is used to circulate the water. The water flows around and under the drinking bowl and enters the bowl only when an animal ac-

tivates the flow control valve. However, the cost of operating such a system in a large number of livestock market pens may be excessive.

Runoff from Noncovered Pens

Another source of wastes and waste water is caused by runoff from noncovered pens. Some markets use these pens only on large sale days. Generally speaking, markets in the southwestern and western parts of the United States use noncovered pens because rainfall in these areas is less.

Runoff from noncovered pens is caused by rainfall, snowmelt, water-trough overflow, and urine. When these pens are used daily, they probably have some type of impervious floor, unless they are located in drier areas of the United States, namely the Southwest.

The volume of runoff from noncovered pens depends on the amount and intensity of rainfall and snowmelt, type of floor, surrounding

drainage, slope of pen floor, amount of manure and bedding, and maintenance frequency and practices.

Bedding and manure absorb and retain water in pens during rainfall events, except when rain has fallen within the previous 3 days and the material is already wet. For example, research data from tests conducted more than 3 years in eastern Nebraska showed that an unpaved beef feedlot holds about the first 1.27 cm (0.5 in) rainfall, unless rain has fallen within the previous 3 days (3). Also, higher rainfall intensities caused earlier initial runoff, higher runoff rates, and increased total runoff.

A rule of thumb for estimating the amount of liquid runoff from an unpaved feedlot is

$$Q = 0.7P$$

where Q represents runoff and P represents rainfall, and both are in inches. This applies for rainfall values greater than 1.27 cm (0.5 in) and based on storms under 1.27 cm (0.5 in), resulting in little runoff from unpaved lots (2).

Rainfall on paved feedlots results in almost complete runoff, although in paved lots with manure and bedding in them up to 0.64 cm (0.25 in), some runoff may be retained.

The above rules were derived from feedlot tests. Characteristics of runoff from noncovered holding pens at livestock markets will be different from runoff from feedlots. However, these rules might be used to estimate amount of runoff.

Solids in the runoff from unpaved lots in the above tests ranged up to approximately 2.2 percent, with the average of 0.75 percent. A reasonable design estimate for the amount of solids in the runoff from unpaved holding pens would be 1.5 percent.

Transport Trucks

Still another source of livestock market wastes will be the material cleaned from transport trucks. After delivering livestock to a market, some truck operators clean their trucks before returning to their base of operations, loading and transporting other animals, or returning a load of another commodity such as feed or fertilizer. Material used as bedding on the truck bed floor includes sand, sawdust or wood chips, and straw or hay.

Some markets have an area where the trucks can be cleaned and the material stored on the ground. Other markets have concrete holding pits similar to a horizontal silo. Trucks can be backed up to this pit and the material from the truck bed removed directly to the holding pit.

At one time, some markets had truck-washing facilities. The truckers were instructed to dryclean the bulk of the material from the truck bed and either pile it or place it in a pit before proceeding to the wash rack. Because many truckers preferred to wash all of the material from their trucks, these installations became a heavy load for the waste treatment plants. As a result, most of these truck washes have been closed.

CLEANING METHODS

Two methods are available for removing wastes from holding pens and alleys: the solid state and the wet (or liquid) state.

Solid Removal

Removal in the solid state does not mean that the material is dry. In fact, it may be very wet. But the material is handled as a solid rather than a liquid.

Removing manure and bedding from holding pens is generally done with power equipment. Currently, most markets use mechanical loaders. These vary from tractor loaders with regular steering to loaders with skid or articulated steering. The regular tractor loaders can be further classified as loaders with narrow or wide front ends. Skid steering loaders vary in width, and some of them can be operated in a 91.44 cm-(3 ft) wide alley.

These loaders deposit wastes into piles or windrows from which it is then loaded into trucks or wagons equipped with dump beds or mechanical unloaders. Some markets use tractors equipped with blades to remove material from the pens to the alleys. Then it is removed from the alleys with loaders. If pens are covered and have concrete floors, some markets have used powered brooms to remove the waste material after it has dried. And because of the design and layout of some pens, feeders, and waterers, hand labor may be necessary if all the material is to be removed.

Liquid Removal

Using water as a carrier is necessary to remove waste materials. Bedding is not used on pen floors that are washed to remove manure and urine. Markets using this system have impervious floors and alleys, which are usually concrete, and wastes are washed to open-drain channels in alleys and pens. Ideally, the drain would be located where four pens have a common corner, and thus the drain would serve all four pens.

DISPOSAL OF WASTES

The final disposal of liquid and solid wastes from open and covered livestock market pens is diagrammed in figures 1 and 2 (4).

Liquid Wastes

Liquid wastes result from cleaning pens and alley floors with water from open pens exposed to rain or snowfall. These liquids are collected in a sewer system that could be an open channel, a covered channel, or a buried sewer pipe.

The channel could be covered with a variety of materials. Most popular are metal and wood. The metal is generally steel and welded to form some type of grate, which may also be made of cast iron, and cast with the desired spacing in the grate. Spacing of 0.64 to 1.27 cm (0.25 to 0.5 in) is provided in a grate used for liquid wastes to enter the channel.

Channeled liquids then flow to a sewer line that is buried below frost lines and sized to handle the volume of liquids flowing from the market.

Total liquid volume handled depends on the floor area of the pens and alleys that is washed, the number of head of livestock that have occupied the holding pens, and the amount of waste on the pen floor.

Tests were run at a cooperating livestock market to determine the amount of water and time required to clean alley and pen floors. Alley washing was at a rate of 0.1044 m²/L (4.25

ft²/g) of water; pen washing was at the average rate of 0.1474 m²/L (6 ft²/g) of water. The range was from 0.0799 to 0.1966 m²/L (3.25 to 8 ft²/g) of water. Washing time was 3.557 m²/min (38.25 ft²) for alleys and 7.673 m²/min (82.5 ft²) for pen floors.²

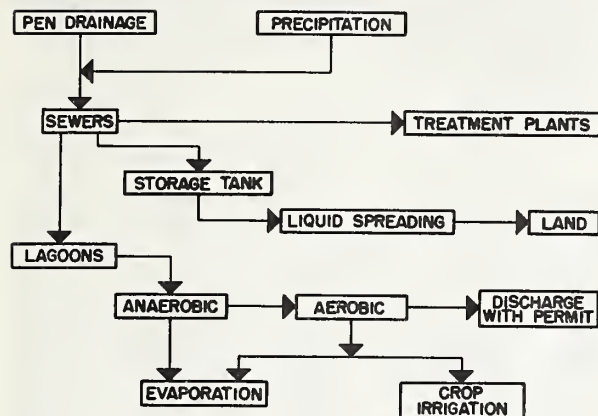
Water was also used to sprinkle butcher-weight hogs during hot weather to control dust and to cool the hogs. This amounted to 2.157 L/hog (0.57 g) handled each day.

Total volume of wastes flowing to a sewer ranged from a fraction of a gallon per minute to over 68.13 L/min (18 g) for 4 hours. The market at which these data were collected operated two sale rings—one 5 days a week and the other 4 days a week. During the tests, the approximate number of livestock handled was 1,000 head of slaughter swine on a daily basis, 1,500 head of feeder pigs 1 day a week, 1,200 feeder cattle 1 day a week, and 600 fat cattle 1 day a week. Figures on the volume of wastes are an average of several tests for 2 years. During cold weather the volume of wastes was reduced.

Sewage costs for livestock wastes are assessed on the basis of the total volume of wastes handled. An additional charge may be based on the biochemical oxygen demand (BOD) or the chemical oxygen demand (COD) of the material. Livestock wastes have higher BOD and COD values than municipal sewage.

² m²/L = square meters per liter; ft²/g = square feet per gallon; m²/min = square meters per minute.

OPEN PENS LIQUID & SOLID WASTES



COVERED PENS LIQUID & SOLID WASTES

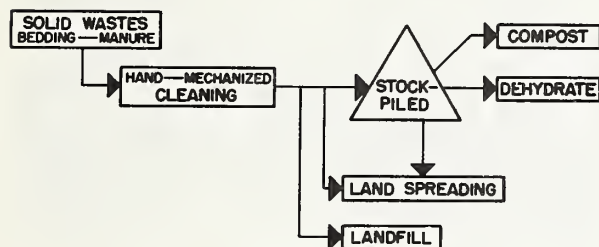
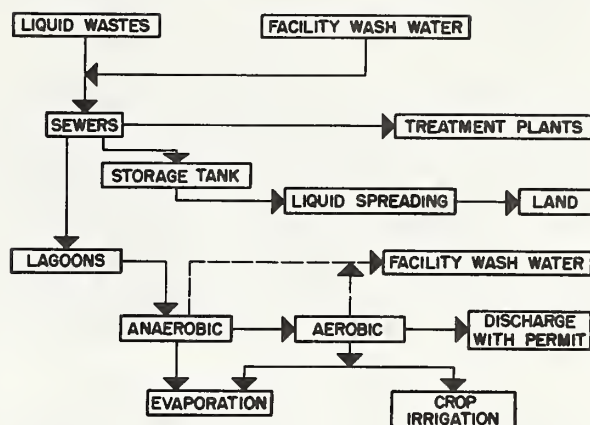


Figure 1.

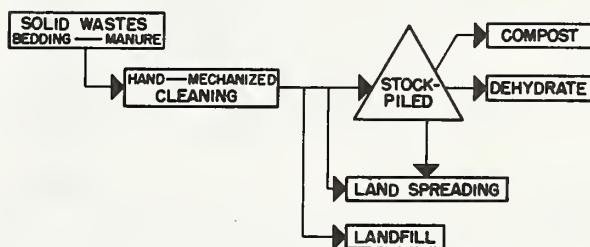


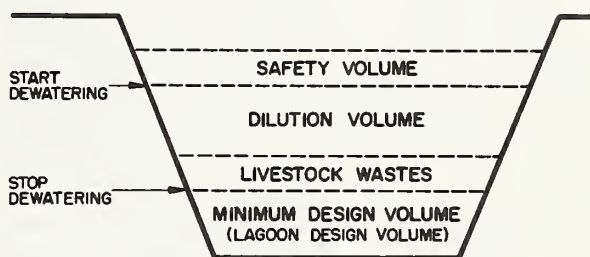
Figure 2.

LAGOONS

Some markets use aerobic, anaerobic, or facultative lagoons to treat liquid wastes. Facultative lagoons serve as a combination anaerobic-aerobic, aerobic lagoons have a large surface area with a depth less than 1.52 m (5 ft), and anaerobic lagoons are smaller in surface area and are deeper. The effluent (outflow) from an anaerobic lagoon does not meet the quality standards required for discharges to a receiving stream. Some states may require the liquid wastes from a livestock market be processed through one anaerobic and two aerobic lagoons before being discharged to receiving streams. A discharge permit may also be required.

The main components of a lagoon to handle livestock wastes are labeled in figure 3. These include minimum design volume, livestock waste volume, dilution volume, and safety volume. The first consideration is the volume required to store the livestock wastes for a spe-

cific time. The table for livestock waste is for production units for each 24-hours per 1,000 pounds of animal weight. Livestock at a market are generally held less than 24 hours. Therefore, volume is difficult to predict unless livestock arrival and departure times for each lot



DILUTION VOLUME = ACCUMULATED WATER FROM—
WASH WATER, SURFACE DRAINAGE FROM PERIMETER OF LAGOON, OVERFLOW FROM WATERERS, ROOF WATER AND RAINFALL MINUS EVAPORATION ON LAGOON SURFACE

Figure 3.—Components of a lagoon.

are monitored. A fairly reliable value can be determined for the total hours each species uses the facility. Then the value of livestock waste production from the table can be adjusted.

Minimum lagoon design volume is the volume required to maintain adequate and viable bacterial populations for waste decomposition. Liquid level in the lagoon should be above the minimum design volume to improve waste treatment and reduce odors. Minimum design volume is determined by the number of animals, their species, weight, holding time, and the climatic location of the lagoon.

Dilution volume is the amount of water that accumulates in the lagoon between each dewatering period. Dewatering can be accomplished by pumping or gravity flow. This accumulated water comes from wash water, overflow from livestock waterers, diverted roof water, surface drainage water from the perimeter area of the lagoon, rainfall minus evaporation on the lagoon surface and, if necessary, pumped water from a well or other source. Accumulated water is required to maintain the decomposition rate of wastes. It also is required to prevent lagoon malfunction from high concentrations of organic matters and salts.

The safety volume should be reserved at the top of the lagoon for storing expected severe storms. Safety volume includes an allowance for a 25-year, 24-hour storm, or the accumulated series of storms expected during the dewatering period. A dewatering time of 20 days after the lagoon level reaches the bottom of the prescribed safety volume level is used for some animal production unit lagoons.

Safety volume depth is determined by 30.48 cm (1 ft) minimum water falling on the lagoon surface plus 10.16 cm (4 in) for each acre of watershed draining into the lagoon. Anytime the safety volume is allowed to be less than 30.48 cm (1 ft) from overflow, there is the risk of the 25-year, 24-hour storm occurring, causing the lagoon to overflow.

Managing Anaerobic Lagoons

Anaerobic lagoons must be designed, constructed, and managed properly if they are to

perform efficiently. They are "biologically living" systems. They must be managed to maintain a healthy population of living bacteria that will insure maximum solids reduction with minimum odors.

Before adding wastes, fill a new lagoon to the minimum design volume with surface runoff, roof runoff, or well water. Add water any time the water level in the lagoon is below the minimum-design volume level. One method for reducing the minimum-design volume is to screen the solids from the material entering the lagoon. The solids are stockpiled and disposed of by one of the methods described in the section on solid waste disposal. The lagoon is then being used as a treatment method for the dissolved and suspended solids in the liquid.

Start a new lagoon at the beginning of warm weather because warmer temperatures allow bacteria to grow more quickly. Take samples from the lagoon frequently and measure the pH. If the pH is below 6.7, add hydrated lime or caustic soda (lye) at the rate of 454 g/93 m² (1 lb/100 ft²/d) until the pH is neutral (pH = 7.0).

If possible, load the lagoon daily. However, operating and cleaning the market may not be on a daily schedule. "Slug loading" manure will cause a rapid increase in volatile acids and a lowering of pH. Methane bacteria in the lagoon are sensitive to pH below 6.7, and the bacterial population will be reduced. If this occurs, the lagoon will not function properly and will produce excessive odors.

If slug loading is unavoidable, design for this consideration and add the required quantities of the hydrated lime or caustic soda with the manure. This will minimize the changes in pH.

A lagoon that is allowed to overflow may erode the earthen dam and cause it to fail. Also, an overflowing lagoon may be in violation of state water pollution laws, thus subjecting the owner to legal penalties.

Rainfall and Evaporation

One of the items included in the dilution volume of a lagoon is rainfall minus evaporation on

the lagoon surface. In some areas, evaporation exceeds rainfall for the yearly accumulated totals, or for monthly, or combination of monthly accumulated totals. In other areas, rainfall exceeds evaporation for the yearly accumulated totals, or for the monthly, or combination of monthly accumulated totals.

In the Midwest, accumulated totals of rainfall minus evaporation for the 5- or 6-month period beginning November 1 and ending March 31 or April 30 ranged from 12.7 cm (5 in) to 25.4 cm (10 in) for 1 year out of every 2 years, or 50 percent of the time. This accumulation occurs during the winter months when the ground is frozen. Time available during this period for dewatering a lagoon is limited; therefore, it would be advisable to dewater a lagoon to the minimum design volume in October.

Accumulated totals of rainfall minus evaporation for the 5- or 6-month period beginning April 1 or May 1 and ending October 30 varied depending on whether the Midwest summer was wet or dry. In a wet summer, totals ranged from 15.24 cm (6 in) to -30.48 cm (12 in). Fifty percent of the time the accumulated totals ranged from -15.24 cm (6 in) to -50.8 cm (20 in). In a dry summer, with a reoccurrence interval of 1 year in 10 years, the accumu-

lated totals ranged from -38.1 cm (15 in) to -88.9 cm (35 in).

During the summer, when the evaporation exceeds rainfall, water may have to be added to maintain the minimum design volume. This will be especially true if the lagoon is dewatered in the spring and a dry summer occurs. Adding water to maintain the minimum design volume level helps to maintain the proper balance of chemicals, salts, and solids in the lagoon for maximum bacterial action.

Removing Liquids from Lagoons

Liquids removed from the anaerobic or aerobic lagoons could be used to irrigate growing crops. Lagoon liquid can also be recycled for washing pen floors and alleyways. This is one method for reducing the total amount of water, usually potable, used by livestock markets to wash pen floors and alleyways. Excessive water uses increases costs for treating wastes.

When using lagoon water as a cleaning medium, we advise a separate piping system. Danger of contaminating the normal water supply is eliminated, and it also can be an important factor in the health and safety of employees.

SOLID WASTES

Solid wastes from livestock markets can be treated by composting or dehydrating and disposed of by spreading on land. Temporary storage for these methods can be achieved by stockpiling. Regardless of the method used, the end product must be returned to the land. Although the first two methods require additional manpower to operate the composter or dehydrator, their main advantage is that they reduce the volume of the material to be disposed.

One of the items that must be considered when spreading wastes on land is the runoff. Regulations, again, govern runoff from this type of disposal. In some states, spreading of wastes may be prohibited on frozen land. Spreading may also be restricted during wet weather, both by regulations and by the inability to operate spreading equipment on wet

lands. And to prevent pollution, provisions must be made to control seepage from the stockpiles.

Wastes spread on land owned or leased by the livestock market will increase land fertility. For example, a livestock market might purchase a parcel of land low in fertility and use the wastes in a soil-building program. Of course, the distance wastes must be transported on highways must be considered for economic reasons.

Some markets used to have reasonable success in selling livestock wastes to farmers but, as commercial fertilizers became cheaper, this market all but disappeared. Some nursery operators still continue to use livestock wastes. Livestock markets have even given livestock wastes away, if the farmer would haul it or pay for hauling it. In recent years, however, as

commercial fertilizers have become scarce, as well as costly, interest has been renewed in livestock wastes as fertilizer.

A few markets have tried landfills as a means of disposal, although regulations governing runoff and seepage have restricted such use for livestock wastes.

A few small markets have used sanitary landfills as a disposal for livestock wastes. These wastes, incorporated into the top foot of soil at a high application rate per acre, aid in establishing a grass or legume crop on the surface of the completed landfill.

CONCLUSIONS

No specific guidelines for disposing of wastes apply to all livestock markets. Each market is a separate, distinct operation, and each has a different mix of livestock. To answer specific questions pertaining to waste disposal in a specific state, we would suggest contacting (1) a state water pollution or environmental agency,

(2) an extension agricultural engineer specializing in livestock waste disposal, or (3) a consulting engineering firm knowledgeable in livestock wastes. They would also be able to advise whether specific permits are required for any of the methods or procedures described in this publication.

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